MEDIA BACKGROUNDER: Micro Electrical Mechanical Systems (MEMS) technology microvalve for fuel cell flow control

CONTEXT

Although discovered more than a century ago, fuel cells have received much recent attention. The benefits to the nation of widespread fuel cell could be significant. Fuel cells currently in development produce only trace amounts of sulfurous pollutants and reduced, concentrated, and readily captured volumes of CO_2. Fuel cells are also more efficient than combustion technologies in converting the chemical energy of hydrocarbons into electricity, allowing them to produce more power per unit of consumed fuel. Because fuel cells have few moving parts, they are safe, quiet, and reliable, making them a key technology in continuing the global trend toward more efficient and environmentally sound energy use.

A fuel cell is an electrochemical device, which directly converts chemical energy stored in a fuel (e.g. hydrogen) and an oxidizer (e.g. oxygen) directly into electrical energy. The reactant gases flow through a labyrinth of flow channels that are lined with catalyzed electrodes which are sandwiched about an electrolyte material.

PROCESS

A fuel cell's electrical potential (voltage) is limited by the concentrations of reactants (fuel and oxidizer) at the electrode surface. If the concentration of one or both of the reactants drops to a low value, the cell's voltage will also drop.

Currently, fuel cell designers try to manage the concentrations of needed reactants by imposing relatively large pressure drops across the flow channels throughout the total cell, thereby attempting to ensure adequate flow in each individual channel within the cell. The National Energy Technology Laboratory (NETL) and the University of Pittsburgh are proposing an alternate solution where small microvalves are integrated into the fuel cell stack to reliably provide improved flow distribution and higher efficiency, at a reasonable cost.

PROBLEM

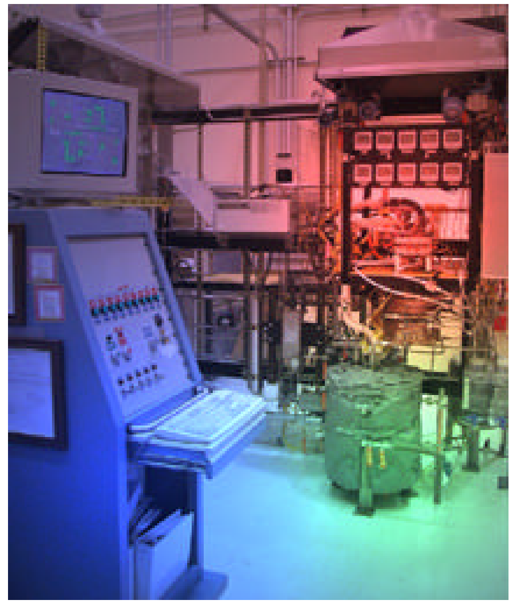
A new design is necessary because commercially available microvalve designs do not meet the fuel cell application requirements including hydrogen tolerance, thermal-insensitive activation mechanism, and geometric constraints.

RESEARCH/SOLUTION

Researchers at the NETL and the University of Pittsburgh have designed and are manufacturing a piezoelectrically actuated microvalve for flow control in a PEM fuel cell. Characteristics of the design include:

- scalable geometry (height and width)
- axial flow
- relatively simple operation (reliable)
- non-thermally activated
- low-voltage operation
- linear actuator response

Because the design employs MEMS technology, the basic fabrication techniques are borrowed from the semiconductor industry, promising high volume, low-cost production. An entire valve measures only 20mm length, by 4mm width, by 290 micrometer thickness. Researchers, who say the valve is also applicable to higher temperature solid oxide fuel cells (SOFC), will be testing and evaluating the new concept and design at NETL's fuel cell testing facility (photo) in Morgantown, West Virginia.



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